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In re Application of: Suryanarayanan et al.	§	Group Art Unit: 3768	
Serial No.: 10/723,192	§	Examiner:	Bemben, Richard M.
Filed: November 25, 2003	§		
For: METHOD AND APPARATUS FOR SEGMENTING STRUCTURE IN CT ANGIOGRAPHY	§	Atty. Docket: GERD:0073	140312-1/YOD

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APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 41.31 AND 41.37

This Appeal Brief is being filed in furtherance to the Notice of Appeal mailed on October 13, 2007, and received by the Patent Office on October 13, 2007.

1. **REAL PARTY IN INTEREST**

The real party in interest is General Electric Company, the Assignee of the above-referenced application by virtue of the Assignment to General Electric Company by Srikanth Suryanarayanan recorded at reel 014753, frame 0010, and dated November 25, 2003. Accordingly, General Electric Company, as the parent company of the Assignee of the above-referenced application, will be directly affected by the Board's decision in the pending appeal.

2. **RELATED APPEALS AND INTERFERENCES**

Appellant are unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellants' legal representative in this Appeal.

3. **STATUS OF CLAIMS**

Claims 1-39 are currently under final rejection and, thus, are the subject of this Appeal.

4. **STATUS OF AMENDMENTS**

Appellants' amendment dated September 17, 2007, submitted subsequent to the final rejection, dated, July 13, 2007 was denied entry by the Examiner because it raised issues that required further consideration and/or search. Appellants hereby request that the Board consider this outstanding amendment presented in the Appeal Brief.

5. **SUMMARY OF CLAIMED SUBJECT MATTER**

The present invention relates generally to the field of volumetric medical imaging. More particularly, in certain embodiments, the invention relates to a technique for segmenting bone and vasculature data in computed tomography. See Application, page 1, lines 6-9.

The Application contains four independent claims, namely, claims 1, 14, 27 and 39, all of which are the subject of this Appeal. The subject matter of these claims is summarized below.

With regard to the aspect of the invention set forth in independent claim 1, discussions of the recited features of claim 1 can be found at least in the below cited locations of the specification and drawings. Claim 1 recites a method for generating a bone mask. The method includes acquiring an image data set (*e.g.*, 70) and pre-processing the image data set (*e.g.*, 70) to automatically calculate one or more seed points and one or more structure edges. *See, e.g., id.* at page 11, line 6-7; and page 14, lines 19-21; *see also* Fig. 3. The method further includes generating a preliminary bone mask (*e.g.*, 76) to differentiate bone and vascular structures from the image data set (*e.g.*, 70). *See, e.g., id.* at page 15, lines 27-28; *see also* Fig. 3. The preliminary bone mask (*e.g.*, 76) is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume. *See, e.g., id.* at page 13, lines 24-26; *see also* Figs. 3 and 4. The method then comprises automatically determining the vascular structure (*e.g.*, 78) using the one or more seed points, the one or more structure edges, and the image data (*e.g.*, 70). *See, e.g., id.* at page 14, lines 21-23; and page 16, lines 23-24; *see also* Fig. 3. The method finally includes subtracting the vascular structure (*e.g.*, 78) from the preliminary bone mask (*e.g.*, 76) to generate a bone mask (*e.g.*, 82). *See, e.g., id.* at page 18, lines 30-31; *see also* Fig. 3.

With regard to the aspect of the invention set forth in independent claim 14, discussions of the recited features of claim 14 can be found at least in the below cited locations of the specification and drawings. Claim 14 recites a computer program, provided on one or more computer readable media, for generating a bone mask. The computer program comprises a routine for acquiring an image data set (*e.g.*, 70) and pre-

processing the image data set (*e.g.*, 70) to automatically calculate at least one or more seed points and one or more structure edges. *See, e.g., id.* at page 11, line 6; and page 14, lines 19-21; *see also* Fig. 3. The computer program further includes generating a preliminary bone mask (*e.g.*, 76) to differentiate bone and vascular structures from the image data set (*e.g.*, 70). *See, e.g., id.* at page 15, lines 27-28; *see also* Fig. 3. The preliminary bone mask (*e.g.*, 76) is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume. *See, e.g., id.* at page 13, lines 24-26; *see also* Figs. 3 and 4. The computer program then comprises automatically determining the vascular structure (*e.g.*, 78) using the one or more seed points, the one or more structure edges, and the image data (*e.g.*, 70). *See, e.g., id.* at page 14, lines 21-23; and page 16, lines 23-24; *see also* Fig. 3. The computer program finally includes subtracting the vascular structure (*e.g.*, 78) from the preliminary bone mask (*e.g.*, 76) to generate a bone mask (*e.g.*, 82). *See, e.g., id.* at page 18, lines 30-31; *see also* Fig. 3.

With regard to the aspect of the invention set forth in independent claim 27, discussions of the recited features of claim 27 can be found at least in the below cited locations of the specification and drawings. Claim 27 recites a CT image analysis system (*e.g.*, 10). *See, e.g., id.* at page 5, lines 19-20; *see also* Fig. 1. The system (*e.g.*, 10) comprises an X-ray source (e.g., 12) configured to emit a stream of radiation (*e.g.*, 16). *See, e.g., id.* at page 5, line 29 to page 6, lines 1-2; *see also* Fig. 1. The system (*e.g.*, 10) comprises a detector (*e.g.*, 22) configured to detect the stream of radiation (*e.g.*, 16) and to generate one or more signals responsive to the stream of radiation (*e.g.*, 16). *See, e.g., id.* at page 6, lines 2-5; *see also* Fig. 1. The system (*e.g.*, 10) further comprises a system controller (e.g., 24). *See, e.g., id.* at page 6, lines 8-9; *see also* Fig. 1. The system controller (*e.g.*, 24) is configured to control the X-ray source (*e.g.*, 12) and to acquire a set of image data (*e.g.*, 70) from one or more of the detector elements (*e.g.*, 22) via a data

acquisition system (*e.g.*, 34). *See, e.g., id.* at page 6, lines 8-9; and page 7, lines 7-11; *see also* Fig. 1. The system (*e.g.*, 10) further comprises a computer system (*e.g.*, 36) that is configured to receive the set of image data (*e.g.*, 70) and to pre-process the set of image data (*e.g.*, 70) to automatically calculate one or more seed points and one or more structured edges. *See, e.g., id.* at page 11, line 6-7; and page 14, lines 19-21; *see also* Figs. 1 and 3. The computer system (*e.g.*, 36) is further configured to generate a preliminary bone mask (*e.g.* 76) to differentiate bone and vascular structures from the set of image data (*e.g.*, 70). *See, e.g., id.* at page 15, lines 27-28; see *also* Fig. 3. The preliminary bone mask (*e.g.*, 76) is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume. *See, e.g., id.* at page 13, lines 24-26; *see also* Figs. 3 and 4. The computer system (*e.g.*, 36) is then configured to automatically determine the vascular structure (*e.g.*, 78) using the one or more seed points, the one or more structure edges, and the set of image data (*e.g.*, 70). *See, e.g., id.* at page 14, lines 21-23; and page 16, line 23-24; *see also* Fig. 3. The computer system (*e.g.*, 36) is then configured to subtract the vascular structure (*e.g.*, 78) from the preliminary bone mask (*e.g.*, 76) to generate a bone mask (*e.g.*, 82). *See, e.g., id.* at page 18, lines 30-31; *see also* Fig. 3.

With regard to the aspect of the invention set forth in independent claim 39, discussions of the recited features of claim 39 can be found at least in the below cited locations of the specification and drawings. Claim 39 recites a CT image analysis system (*e.g.*, 10). *See, e.g., id.* at page 5, lines 19-20; *see also* Fig. 1. The system (*e.g.*, 10) comprises means for acquiring an image data set (*e.g.*, 70) and means for pre-processing the image data set (e.g., 70) to automatically calculate at least one or more seed points and one or more structure edges. *See, e.g., id.* at page 11, line 6-7; and page 14, lines 19-21; *see also* Figs. 1 and 3. The system (e.g., 10) further includes means for generating a preliminary bone mask (*e.g.* 76) to differentiate bone and vascular structures from the set

of image data (*e.g.*, 70). *See, e.g., id.* at page 15, lines 27-28; *see also* Fig. 3. The preliminary bone mask (*e.g.*, 76) is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume. *See, e.g., id.* at page 13, lines 24-26; *see also* Figs. 3 and 4. The system (*e.g.*, 10) further comprises means for automatically determining the vascular structure (*e.g.*, 78) using the one or more seed points, the one or more structure edges, and the set of image data (*e.g.*, 70). *See, e.g., id.* at page 14, lines 21-23; and page 16, line 23-24; *see also* Fig. 3. The system (*e.g.*, 10) then comprises means for subtracting the vascular structure (*e.g.*, 78) from the preliminary bone mask (*e.g.*, 76) to generate a bone mask (*e.g.*, 82). *See, e.g., id.* at page 18, lines 30-31; *see also* Fig. 3.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

First Ground of Rejection for Review on Appeal:

Appellants respectfully urge the Board to review and reverse the Examiner's first ground of rejection in which the Examiner rejected claims 1-6, 10-19, 23-31 and 35-39 under 35 U.S.C 102(e) as being anticipated by US Patent No. US 6,842,638 B1 (hereinafter, "Suri").

Second Ground of Rejection for Review on Appeal:

Appellants respectfully urge the Board to review and reverse the Examiner's second ground of rejection in which the Examiner rejected claims 7-9, 20-22 and 32-34 under 35 U.S.C 103(a) as being unpatentable over Suri in view of US Patent No. US 6,351,571 B1 (hereinafter, "VanMetter").

7. **ARGUMENT**

As discussed in detail below, the Examiner has improperly rejected the pending claims. Further, the Examiner has misapplied long-standing and binding legal precedents and principles in rejecting the claims under Sections 102 and 103. Accordingly, Appellants respectfully request full and favorable consideration by the Board, and reversal of the outstanding rejections.

A. Ground of Rejection No. 1

The Examiner rejected independent claims 1-6, 10-19, 23-31 and 35-39 under 35 U.S.C 102(e) as being anticipated by US Patent No. US 6,842,638 B1 ("Suri"). Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration.

Claims 1, 7, 8, 14, 20, 21, 27, 32, 33 and 39 have been amended (per Applicant's amendment dated September 17, 2007 in response to the final rejection dated July 13, 2007) to more clearly recite the invention. Support for the amendments can be found in Appellants' specification at, for example, page 13, lines 24-26. No new matter has been added.

Claims 1, 14, 27 and 39 and claims depending therefrom

Claims 1 and 14 are directed to a method and computer program for generating a bone mask. The method and computer program comprise the steps of acquiring an image data set and pre-processing the image data set to automatically calculate at least one or more seed points and one or more structure edges. The method and computer program further comprise the step of generating a preliminary bone mask to differentiate bone and vascular structures from the image data set, wherein the preliminary bone mask is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vasculature structures in the plurality of

sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and vascular structures in the sub-volume. The method and computer program then comprise automatically determining the vascular structure using the one or more seed points, the one or more structure edges, and the image data and subtracting the vascular structure from the preliminary bone mask to generate a bone mask.

Claims 27 and 39 are directed to a CT image analysis system. The system comprises an X-ray source configured to emit a stream of radiation and a detector configured to detect the stream of radiation and to generate one or more signals responsive to the stream of radiation, wherein the detector comprises a plurality of detector elements. The system further comprises a system controller configured to control the X-ray source and to acquire a set of image data from one or more of the detector elements via a data acquisition system. The system further comprises a computer system configured to receive the set of image data, to pre-process the set of image data to automatically calculate at least one or more seed points and one or more structure edges, to generate a preliminary bone mask to differentiate bone and vascular structures from the set of image data, wherein the preliminary bone mask is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structure in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume, automatically determine the vascular structure using the one or more seed points, the one or more structure edges, and the set of image data and to subtract the vascular structure from the preliminary bone mask to generate a bone mask.

Suri discloses an apparatus for producing an angiographic image representation of a subject. Further, Suri discloses a method and apparatus for characterizing and tracking a vascular system in a three-dimensional angiographic image (Summary of the invention). In particular, in Suri, raw angiographic volume image data is acquired and pre-processed

to produce an angiographic volume (Col. 8, lines 40-42). The pre-processed volume is input to a three-dimensional feature processor, which outputs a three-dimensional edge volume (Col. 3, lines 57-60). The edge volume is then processed on a slice-by-slice basis to identify vessel centers throughout the volume of interest, which are representative of the imaged vascular system (Col. 9, lines 1-4). In one embodiment, the processing includes removing any non-vascular dark or black regions in the angiographic volume by constructing a binary bone-air-muscle mask (Col. 11, lines 39-43). Each pixel of the image slice is assigned as either a black pixel or a gray pixel, corresponding to bone/air/vascular structures and tissue background respectively to generate an intermediate binary slice mask (Col. 12, lines 30-37). A mask processor removes the vascular regions from the intermediate mask (Col. 12, lines 42-43) and the resulting slice mask contains the non-vascular structures with the blood vessels removed (Col. 12, 51-53).

Appellants respectfully submit that Suri does not teach at least the step of generating a preliminary bone mask to differentiate bone and vascular structures from the image data set, wherein the preliminary bone mask is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume as recited in independent claims 1, 14, 27 and 39.

Specifically, and as mentioned above, Appellants point out that the intermediate binary slice mask in Suri, is created by assigning each pixel in the image slice as either a black pixel corresponding to bone/air/vascular structures or a gray pixel corresponding to tissue background. See, e.g., Suri, col. 12, lines 28-37. In other words, the pixel classification performed by Suri generates an intermediate binary slice mask *that does not differentiate between vascular and non-vascular structures (i.e., bone structures).* A mask processor subsequently removes the vascular regions from the intermediate mask

(Col. 12, lines 42-43) and the resulting slice mask contains the non-vascular structures with the blood vessels removed (Col. 12, 51-53).

In contrast, in the present patent application, the preliminary bone mask differentiates between bone and vascular structures in the image data set and the preliminary bone mask is generated for various sub-volumes comprising the image data set, wherein each identified sub-volume varies in its degree of spatial separation between bone and vessel. See, e.g., Application, page, 13, lines 24-26. Specifically, and as recited in claims 1, 14, 27 and 39, the preliminary bone mask is generated to differentiate bone and vascular structures from the image data set and is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and vascular structures in the sub-volume. Accordingly, the sub-volumes thus generated, which have a good spatial separation between bone and vessel enables greater emphasis on techniques such as connected components to distinguish between bone and vessel structures. See, e.g., Application, page 12, lines 11-13. For example, the spatial separation determined between bone and vessel regions in the proximal sub-volume may be used to implement a much faster routine to extract bone and vessel. See, e.g., Application, page 13, lines 26-28.

Because, Suri does not disclose at least the step of generating a preliminary bone mask to differentiate bone and vascular structures from the image data set, wherein the preliminary bone mask is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume, Suri cannot anticipate claims 1, 14, 27 and 39. Accordingly, claims 1, 14, 27 and 39 and claims depending therefrom are believed to be clearly patentable over Suri as

well as other prior art of record. Thus, Appellants respectfully request that the Board reverse the rejection of claims 1-6, 10-19, 23-31, 35-39 under 35 U.S.C 102(b).

B. Ground of Rejection No. 2

The Examiner rejected claims 7-9, 20-22 and 32-34 under 35 U.S.C 103(a) as being unpatentable over Suri in view of US Patent No. US 6,351,571 B1 ("VanMetter"). For a prima facie case of obviousness, the Examiner must set forth the differences in the claim over the applied reference, set forth the proposed modifications of the reference, which would be necessary to arrive at the claimed subject matter, and explain why the proposed modification would be obvious.

As summarized above, all of the independent claims are believed to be patentable over Suri. The VanMetter reference has been reviewed with respect to the 35 U.S.C 103(a) rejection and does not supply the deficiencies of Suri in regards to the step of generating a preliminary bone mask to differentiate bone and vascular structures from the image data set, wherein the preliminary bone mask is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume. For example, the VanMetter reference merely relates to image enhancement in digital image processing and relates to a method for rapidly analyzing the high-and-low-frequency components of pixels in an arbitrarily shaped region of an image without producing artifacts at edges of the region. See, e.g., Van Metter, col. 1, lines 5-10.

Appellants have further amended claims 7, 8, 20, 21, 32 and 33 to conform to the amended claim language of independent claims 1, 14 and 27 respectively. Accordingly, claims 7-9, 20-22 and 32-34 are allowable by virtue of their dependency from allowable

base claims 1, 14 and 27 respectively, as well as for the subject matter they separately recite. Thus, Appellants respectfully request that the Board reverse the rejection of claims 7-9, 20-22 and 32-34 under 35 U.S.C 103(a).

Conclusion

Appellant respectfully submits that all pending claims are in condition for allowance. However, if the Examiner or Board wishes to resolve any other issues by way of a telephone conference, the Examiner or Board is kindly invited to contact the undersigned attorney at the telephone number indicated below.

Respectfully submitted,

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8. APPENDIX OF CLAIMS ON APPEAL

Listing of Claims:

The following is a listing of the claims in accordance with 37 C.F.R. §1.121.

1. (Currently Amended) A method for generating a bone mask, comprising the steps of:

acquiring an image data set;

pre-processing the image data set to automatically calculate at least one or more seed points and one or more structure edges;

generating a preliminary bone mask to differentiate bone and vascular structures from the image data set, wherein the preliminary bone mask is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the ~~image data set~~ plurality of sub-volumes, and wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume;

automatically determining the vascular structure using the one or more seed points, the one or more structure edges, and the image data; and

subtracting the vascular structure from the preliminary bone mask to generate a bone mask.

2. (Original) The method as recited in claim 1, comprising the step of:

subtracting the bone mask from the image data set to generate a bone-free volume data set.

3. (Original) The method as recited in claim 2, comprising the step of:

rendering the bone-free volume data set to generate a bone-free volumetric rendering.

4. (Original) The method as recited in claim 1, wherein acquiring the image data set comprises acquiring a CTA data set of a head and neck region.

5. (Original) The method as recited in claim 1, wherein the step of pre-processing the image data set calculates the one or more seed points using at least one of a geometric template and a functional template.

6. (Original) The method as recited in claim 1, wherein the step of pre-processing the image data set calculates the one or more structure edges by determining a maximum absolute gradient for each voxel relative to the adjacent voxels.

7. (Currently Amended) The method as recited in claim 1, wherein pre-processing the image data set comprises partitioning the image data set into ~~two or more~~ the plurality of sub-volumes.

8. (Currently Amended) The method as recited in claim 7, wherein ~~automatically determining~~ the vascular structure ~~comprises differentially processing~~ is automatically determined based upon the differential processing applied to the ~~two or more~~ plurality of sub-volumes.

9. (Original) The method as recited in claim 8, wherein differentially processing comprises implementing a fast algorithm in at least one sub-volume and a complex vessel tracking algorithm in at least one other sub-volume.

10. (Original) The method as recited in claim 1, wherein pre-processing the image data set comprises removing a portion of the image data set corresponding to a table.

11. (Original) The method as recited in claim 1, wherein generating the preliminary bone mask comprises classifying voxels as bone based on at least intensity.

12. (Original) The method as recited in claim 1, wherein automatically determining the vascular structure comprises applying at least one of a dynamic constrained region growing process, a bubble wave connectivity process, and a ray and contour propagation process.

13. (Original) The method as recited in claim 1, comprising the step of smoothing the vascular structure.

14. (Currently Amended) A computer program, provided on one or more computer readable media, for generating a bone mask, comprising:

a routine for acquiring an image data set;

a routine for pre-processing the image data set to automatically calculate at least one or more seed points and one or more structure edges;

a routine for generating a preliminary bone mask <u>to differentiate bone and vascular structures</u> from the image data set, wherein the preliminary bone mask is

generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the ~~image data set~~ plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume;

a routine for automatically determining the vascular structure using the one or more seed points, the one or more structure edges, and the image data; and

a routine for subtracting the vascular structure from the preliminary bone mask to generate a bone mask.

15. (Original) The computer program as recited in claim 14, comprising a routine for subtracting the bone mask from the image data set to generate a bone-free volume data set.

16. (Original) The computer program as recited in claim 15, comprising a routine for rendering the bone-free volume data set to generate a bone-free volumetric rendering.

17. (Original) The computer program as recited in claim 14, wherein the routine for acquiring the image data set acquires a CTA data set of a head and neck region.

18. (Original) The computer program as recited in claim 14, wherein the routine for pre-processing the image data set calculates the one or more seed points using at least one of a geometric template and a functional template.

19. (Original) The computer program as recited in claim 14, wherein the routine for pre-processing the image data set calculates the one or more structure edges by determining a maximum absolute gradient for each voxel relative to the adjacent voxels.

20. (Currently Amended) The computer program as recited in claim 14, wherein the routine for pre-processing the image data set partitions the image data set into ~~two or more~~ the plurality of sub-volumes.

21. (Currently Amended) The computer program as recited in claim 20, wherein the routine for automatically determining the vascular structure ~~differentially processes~~ is based on the differential processing applied to the ~~two or more~~ plurality of sub-volumes.

22. (Original) The computer program as recited in claim 21, wherein differentially processing comprises implementing a fast algorithm in at least one sub-volume and a complex vessel tracking algorithm in at least one other sub-volume.

23. (Original) The computer program as recited in claim 14, wherein the routine for pre-processing the image data set removes a portion of the image data set corresponding to a table.

24. (Original) The computer program as recited in claim 14, wherein the routine for generating the preliminary bone mask classifies voxels as bone based on at least intensity.

25. (Original) The computer program as recited in claim 14, wherein the routine for automatically determining the vascular structure applies at least one of a dynamic constrained region growing process, a bubble wave connectivity process, and a ray and contour propagation process.

26. (Original) The computer program as recited in claim 14, comprises a routine for smoothing the vascular structure.

27. (Currently Amended) A CT image analysis system, comprising:

an X-ray source configured to emit a stream of radiation;

a detector configured to detect the stream of radiation and to generate one or more signals responsive to the stream of radiation, wherein the detector comprises a plurality of detector elements;

a system controller configured to control the X-ray source and to acquire a set of image data from one or more of the detector elements via a data acquisition system; and

a computer system configured to receive the set of image data, to pre-process the set of image data to automatically calculate at least one or more seed points and one or more structure edges, to generate a preliminary bone mask to differentiate bone and vascular structures from the set of image data, wherein the preliminary bone mask is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the ~~image data set~~ plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume; to automatically determine the vascular structure using the one or more seed points, the one or more structure edges, and the set of image data, and to subtract the vascular structure from the preliminary bone mask to generate a bone mask.

28. (Original) The CT image analysis system as recited in claim 27, wherein the computer system is configured to subtracting the bone mask from the set of image data to generate a bone-free volume data set.

29. (Original) The CT image analysis system as recited in claim 28, wherein the computer system is configured to render the bone-free volume data set to generate a bone-free volumetric rendering.

30. (Original) The CT image analysis system as recited in claim 27, wherein the computer system is configured to pre-process the set of image data by calculating the one or more seed points using at least one of a geometric template and a functional template.

31. (Original) The CT image analysis system as recited in claim 27, wherein the computer system is configured to pre-process the set of image data by calculating the one or more structure edges by determining a maximum absolute gradient for each voxel relative to the adjacent voxels.

32. (Currently Amended) The CT image analysis system as recited in claim 27, wherein the computer system is configured to pre-process the set of image data by partitioning the image data set into ~~two or more~~ the plurality of sub-volumes.

33. (Currently Amended) The CT image analysis system as recited in claim 32, wherein the computer system is configured to automatically determine the vascular structure ~~by differentially processing~~ based on the differential processing applied to the ~~two or more~~ plurality of sub-volumes.

34. (Original) The CT image analysis system as recited in claim 33, wherein differentially processing comprises implementing a fast algorithm in at least one sub-volume and a complex vessel tracking algorithm in at least one other sub-volume.

35. (Original) The CT image analysis system as recited in claim 27, wherein the computer system is configured to pre-process the set of image data by removing a portion of the image data set corresponding to a table.

36. (Original) The CT image analysis system as recited in claim 27, wherein the computer system is configured to generate the preliminary bone mask by classifying voxels as bone based on at least intensity.

37. (Original) The CT image analysis system as recited in claim 27, wherein the computer system is configured to automatically determine the vascular structure by applying at least one of a dynamic constrained region growing process, a bubble wave connectivity process, and a ray and contour propagation process.

38. (Original) The CT image analysis system as recited in claim 27, wherein the computer system is configured to smooth the vascular structure.

39. (Currently Amended) A CT image analysis system, comprising:

means for acquiring an image data set;

means for pre-processing the image data set to automatically calculate at least one or more seed points and one or more structure edges;

means for generating a preliminary bone mask to differentiate bone and vascular structures from the image data set, wherein the preliminary bone mask is generated for a plurality of sub-volumes comprising the image data set, based upon a spatial relationship between the bone and the vascular structures in the ~~image data set~~ plurality of sub-volumes, wherein each sub-volume is differentially processed based upon the spatial relationship between the bone and the vascular structures in the sub-volume;

means for automatically determining the vascular structure using the one or more seed points, the one or more structure edges, and the image data; and

means for subtracting the vascular structure from the preliminary bone mask to generate a bone mask.

9. EVIDENCE APPENDIX

None.

10. RELATED PROCEEDINGS APPENDIX

None.